Chapter 9

Section 9.1

Check Your Understanding, page 541:

1. (a) The parameter of interest is $p =$ proportion of all students at Jannie's high school who get less than 8 hours of sleep at night.
(b) The hypotheses are: $H_0: p = 0.85$ and $H_a: p \neq 0.85$.
2. (a) The parameter of interest is $\mu =$ true mean amount of time that it takes to complete the census form.
(b) The hypotheses are: $H_0: \mu = 10$ and $H_a: \mu > 10$.

Check Your Understanding, page 549:

1. A Type I error is finding convincing evidence that the new batteries last longer than 30 hours on average, when in reality their true mean lifetime is 30 hours.
2. A Type II error is not finding convincing evidence that the new batteries last longer than 30 hours on average, when in reality their true mean lifetime is greater than 30 hours.
3. A consequence of a Type I error would be that the company spends the extra money to produce these new batteries when they aren't any better than the older, cheaper type. A consequence of a Type II error would be that the company would not produce the new batteries, even though they were better. Arguments could be made for either of the errors being worse. For example, with a Type I error, the company would be wasting its money producing a new battery that wasn't any better. With a Type II error the company would be losing out on potential profits by not producing the new, better battery.

Exercises, page 551:

9.1 $H_0: \mu = 115; H_a: \mu > 115$ where μ is the true mean score on the SSHA for all students at least 30 years of age at the teacher's college.

9.2 $H_0: \mu = 12; H_a: \mu < 12$ where μ is the true mean amount of hemoglobin in Jordanian children.

9.3 $H_0: p = 0.12; H_a: p \neq 0.12$ where p is the true proportion of lefties at his large community college.

9.4 $H_0: p = 0.72; H_a: p \neq 0.72$ where p is the true proportion of teens in Yvonne's school who rarely or never argue with their friends.

9.5 $H_0: \sigma = 3; H_a: \sigma > 3$ where σ is the true standard deviation of the temperature in the cabin.

9.6 $H_0: \sigma = 10; H_a: \sigma > 10$ where σ is the true standard deviation of the distance jumped by the ski jumpers.

9.7 The null hypothesis is always that there is "no difference" or "no change" and the alternative hypothesis is what we suspect is true. These ideas are reversed in the stated hypotheses. The hypotheses should be $H_0: p = 0.37; H_a: p > 0.37$.

9.8 Hypotheses are always about population parameters. However, the stated hypotheses are in terms of the sample statistic. Also, we are only interested in whether the situation has improved, so we need a one-sided alternative hypothesis. The hypotheses should be $H_0 : p = 0.37$; $H_a : p > 0.37$.

9.9 Hypotheses are always about population parameters. However, the stated hypotheses are in terms of the sample statistic. The hypotheses should be $H_0 : \mu = 1000$ grams; $H_a : \mu < 1000$ grams.

9.10 The values in both hypotheses must be the same. Also, the null hypothesis should have the equals sign and the alternative should have the less than sign. The hypotheses should be $H_0 : \mu = 1000$ grams; $H_a : \mu < 1000$ grams.

9.11 (a) If the null hypothesis is true, then the mean SSHA for students at least 30 years of age at this school would be 115. This would mean that the attitudes of older students do not differ from other students, on average.
(b) Assuming the mean score on the SSHA for students at least 30 years of age at this school is really 115, there is a 0.0101 probability of getting a sample mean of at least 125.7 just by chance in an SRS of 45 older students.

9.12 (a) If the null hypothesis is true, then the mean hemoglobin level of Jordanian children would be 12. This would mean that Jordanian children are not at risk of anemia, on average.
(b) Assuming the mean hemoglobin level of Jordanian children is really 12, there is a 0.0016 probability of getting a sample mean of 11.3 or smaller just by chance in a random sample of 50 children.

9.13 α = 0.10: Because the *P*-value of 0.2184 is greater than α = 0.10, we fail to reject H_0. We do not have convincing evidence that the proportion of left-handed students at Simon's college is different from the national proportion. α = 0.05: Because the *P*-value of 0.2184 is greater than α = 0.05, we fail to reject H_0. We do not have convincing evidence that the proportion of left-handed students at Simon's college is different from the national proportion.

9.14 (a) α = 0.05: Because the *P*-value of 0.0291 is less than α = 0.05, we reject H_0. We have convincing evidence that the true proportion of teens in Yvonne's school who rarely or never argue with their friends is different than 0.72. α = 0.01: Because the *P*-value of 0.0291 is greater than α = 0.01, we fail to reject H_0. We do not have convincing evidence that the true proportion of teens in Yvonne's school who rarely or never argue with their friends is different than 0.72.

9.15 α = 0.05: Because the *P*-value of 0.0101 is less than α = 0.05, we reject H_0. We have convincing evidence that the true mean score on the SSHA for all students at least 30 years of age at the teacher's college is greater than 115. α = 0.01: Because the *P*-value of 0.0101 is greater than α = 0.01, we fail to reject H_0. We do not have convincing evidence that the true mean score on the SSHA for all students at least 30 years of age at the teacher's college is greater than 115.

9.16 α = 0.05: Because the *P*-value of 0.0016 is less than α = 0.05, we reject H_0. We have convincing evidence that true mean amount of hemoglobin in Jordanian children is less than 12 g/dl. α = 0.01: Because the *P*-value of 0.0016 is less than α = 0.01, we reject H_0. We have convincing evidence that true mean amount of hemoglobin in Jordanian children is less than 12 g/dl.

9.17 The explanation is not correct. Either H_0 is true or H_0 is false—it isn't true some of the time and not true at other times. The *P*-value means that there is a 0.2184 probability of getting a sample proportion of at least as far from 0.12 as the sample result (0.16) in either direction just by chance in an SRS of 100 students, assuming the true proportion of left-handed students at Simon's community college is really 0.12.

9.18 There are two errors in this student's interpretation. First, the interpretation doesn't include a statement that the probability was calculated assuming that the null hypothesis is true. Second, the *P*-value isn't the probability that the sample proportion is exactly 0.64. It is the probability that the sample proportion is *at least* as far away from 0.72 as the sample result, in either direction (because the alternative hypothesis is two-sided).

9.19 There are two problems with this student's conclusion. First, the *P*-value should be compared with a significance level (such as α = 0.05), not the hypothesized value of *p*. Second, the data never "prove" that a hypothesis is true, no matter how large or small the *P*-value. There is always the possibility of error.

9.20 It is never correct to "accept the null hypothesis." If the *P*-value is large, the data do not provide convincing evidence that the alternative hypothesis is true. However, lacking evidence for the alternative hypothesis does not provide convincing evidence that the null hypothesis is true.

9.21 (a) Let μ represent the mean response time for all accidents involving life-threatening injuries in the city. Then the hypotheses are: $H_0 : \mu = 6.7$; $H_a : \mu < 6.7$.
(b) A Type I error would be finding convincing evidence that the mean response time has decreased when it really hasn't. A consequence is that the city may not investigate other ways to reduce the mean response time and more people could die. A Type II error would be not finding convincing evidence that the mean response time has decreased when it really has. A consequence is that the city spends time and money investigating other methods to reduce the mean response time when they aren't necessary.
(c) In this setting a Type I error would be worse because people may end up dying as a result.

9.22 (a) Let *p* represent the proportion of all calls in which first responders arrived within 8 minutes. Then the hypotheses are: $H_0 : p = 0.78$; $H_a : p > 0.78$.
(b) A Type I error would be finding convincing evidence that the proportion of all calls in which first responders arrived within 8 minutes had increased when it really hasn't. A consequence is that the city may not investigate other ways to reduce the response time and more people could die. A Type II error would be not finding convincing evidence that the proportion of all calls in which first responders arrived within 8 minutes had increased when it really has. A consequence is that the city spends time and money investigating other methods to reduce the response time when they aren't necessary.
(c) In this setting a Type I error would be worse because people may end up dying as a result

9.23 (a) $H_0: \mu = \$85{,}000;\ H_a: \mu > \$85{,}000$ where μ = the mean income of all residents near the restaurant.
(b) A Type I error is finding convincing evidence that the mean income of all residents near the restaurant exceeds \$85,000 when in reality it does not. The consequence is that you will open your restaurant in a location where the residents will not be able to support it. A Type II error is not finding convincing evidence that the mean income of all residents near the restaurant exceeds \$85,000 when in reality it does. The consequence of this error is that you will not open your restaurant in a location where the residents would have been able to support it and you lose potential income.

9.24 (a) $H_0: \mu = 130;\ H_a: \mu > 130$ where μ represents the true mean systolic blood pressure of the individual.
(b) A Type I error is finding convincing evidence that the individual's true mean systolic blood pressure is greater than 130, when in reality it isn't. A consequence is that the individual will seek medical attention when it isn't necessary. A Type II error is not finding convincing evidence that the individual's true mean systolic blood pressure is greater than 130, when in reality it is. A consequence is that the individual will not seek medical attention when it is needed, increasing the risk of a stroke or some other problem.

9.25 d

9.26 b

9.27 c

9.28 e

9.29 (a) First, we need to find the proportion of mathematics degrees earned by women.

$$\begin{aligned} P(\text{degree earned by a woman}) &= 0.70(0.43) + 0.24(0.41) + 0.06(0.29) \\ &= 0.3010 + 0.0984 + 0.0174 \\ &= 0.4168 \end{aligned}$$

Because 24,611 degrees were awarded and 41.68% of these degrees were awarded to women, approximately (24,611)(0.4168) = 10,258 mathematics degrees were awarded to women.
(b) The events "degree earned by a woman" and "degree was a bachelor's degree" are not independent. The probability that a degree is earned by a woman is P(woman) = 0.4168. This is not the same as the probability that a degree is earned by a woman, given that it was a bachelor's degree, which is P(woman | bachelors) = 0.43.
(c) Using the fact that 14,353 degrees were not awarded to women, P(at least 1 of the 2 degrees earned by a woman) = 1 – P(neither degree is earned by a woman) =
$1-\left(\frac{14{,}353}{24{,}611}\right)\left(\frac{14{,}352}{24{,}610}\right) = 1 - 0.3401 = 0.6599$. Because the sample size (n = 2) is less than 10% of the population (24,611), we can also approximate this probability assuming the selections are independent. P(at least 1 of the 2 degrees earned by a woman) = 1 – P(neither degree is earned by a woman) = $1 - (1 - 0.4168)^2 = 1 - 0.3401 = 0.6599$.

9.30 One mistake is in saying that 95% of other polls would have results within three percentage points *of the results of this survey*. It should say that other polls would have results within three percentage points *of the true proportion*. Another mistake is saying "at least 19" of the 20 surveys will be within three percentage points when it should say "about 19" of the 20 surveys.